

Evolutionary Patterns of Valley Geomorphology under Wind-Water Interaction Erosion in Ba' erdong Gully, Kongdui District, Inner Mongolia (Postprint)

Authors: Ma Yufeng

Date: 2019-10-11T00:00:00+00:00

Abstract

Taking the middle reach valley segment of Ba' erdong Gully in Kongdui District, Inner Mongolia as the study area, this research addresses the dynamic characteristics of wind-water interaction erosion and the associated geomorphological morphological changes. Based on field investigation and data collection, modern processes of wind-water interaction erosion in the valley were investigated through technical approaches including field meteorological observation, runoff plot experiments, topographic surveying, and remote sensing analysis. The study quantitatively analyzes variations in erosion-deposition patterns across different geomorphological positions and the evolution of valley morphology. The findings reveal that under wind-water interaction erosion, geomorphological types including riverbed dunes, valley-slope dunes, terrace dunes, terrace gullies, and alluvial fan gullies in the middle valley reach undergo cyclical erosion and morphological changes on an annual cycle. Over the years, periodic variations in wind and water forces have caused regular evolution in the geomorphological forms of these interaction erosion units, thereby controlling the morphological changes of the middle Ba' erdong Gully valley. This morphological evolution is primarily manifested in characteristics such as channel sinuosity, channel width, channel migration direction, riverbed cross-section tilt direction, alluvial fan size, and migration distance of valley dunes. This research can provide scientific reference and guidance for soil erosion prevention and control in wind-water erosion interlaced zones.

Full Text**Valley Landform Evolution under Aeolian-Fluvial Joint Erosion in the Baerdong River Basin in Inner Mongolia, China**MA Yufeng¹, YAN Ping², YANG Yuhui³, LI Shuangquan¹¹Institute of Geography, Henan Province Academy of Sciences, Zhengzhou 450052, Henan, China²State Key Laboratory of Earth Surface Processes and Resources Ecology, Beijing Normal University, Beijing 100875, China³Xing'an League Meteorological Bureau, Ulanhot 137400, Inner Mongolia, China

DOI: 10.13866/j.azr.2019.05.26

Received: 2018-11-06; Revised: 2019-02-27

Abstract

The study area is located in the middle reaches of the Baerdong River in Inner Mongolia. This study focused mainly on the dynamic geomorphological evolution caused by aeolian-fluvial joint erosion. Based on field work and collecting the related data, the meteorological observation, runoff plot experiment, topographic survey and remote sensing analysis were applied to study the modern process of aeolian-fluvial joint erosion. The change of erosion pattern of different landforms and the evolution process of valley morphology were quantitatively analyzed. The results showed that the geomorphic types in the middle reaches of the Baerdong River are mainly the dunes on the riverbed, valley slopes and terraces as well as the gullies on the terraces and alluvial fans. The erosion and morphologic evolution of these landforms repeat circularly in a year. Because of the periodic changes of wind speed and water regime, these aeolian-fluvial jointly eroded units have evolved regularly and controlled the change of valley landforms in the middle reaches of the Baerdong River for many years. The morphological changes could be mainly manifested in the river curvature, width of the river channel, shifting direction of the river channel, tilt direction of transverse section of riverbed, size of the alluvial fans and the migration distance of the sand dunes in valley. The study results could be referred in further researching and controlling soil erosion in the aeolian-fluvial joint erosion area.

Keywords: aeolian-fluvial joint erosion; valley landform; evolution law; Baerdong River; Inner Mongolia

3.2 Topographic Survey Data

Topographic survey data were collected using a RIEGL VZ-2000 terrestrial laser scanner. The scanning resolution was set to high-definition mode with a point density of approximately 200 points per square meter. Data collection was conducted during the period 2012-2015, with five scanning sessions in 2012-2014 and twelve sessions in 2015. The scanning range covered the river channel and valley slopes, with each survey area measuring approximately 12 m in scope. The point cloud data were processed using RISCAN software, with coordinate transformation and noise reduction applied to generate digital elevation models (DEMs) with a vertical accuracy of 0.5 m. In 2014, five scanning sessions were conducted, with the 2012 data serving as a baseline for comparison. The 2014 data revealed that the main channel had shifted by 10 cm, while the valley slope erosion depth ranged from 3.5 m to 6.7 m.

3.3 Remote Sensing Analysis

Remote sensing analysis was based on high-resolution satellite imagery from WorldView and GIS data processing. Multi-temporal images from 1978, 1998, 2005, and 2014 were used to analyze changes in valley landforms. The spatial resolution of the imagery was 0.5 m, enabling detailed mapping of channel patterns, sand dune migration, and gully development. GIS analysis included extraction of geomorphic parameters such as channel width, curvature, and erosion area. The results showed that the river channel width decreased from 147.7 m in 1978 to 50.6 m in 2014, while the area of alluvial fans increased from 14,115 m² to 20,340.7 m² during the same period.

3.4 Runoff Plot Experiments

Runoff plot experiments were conducted to quantify erosion rates under simulated rainfall conditions. The experimental plots measured 3 m × 1 m, with slopes ranging from 5° to 10°. Rainfall simulation was performed at intensities of 30-50 mm/h. In 2010, two plots were established with a slope of 5°, rainfall intensity of 30 mm/h, and soil erosion rate of 1.2 m². In 2014, two additional plots were set up with a slope of 5°, rainfall intensity of 10-50 mm/h, and erosion rate of 1.3 m². The experiments demonstrated that aeolian-fluvial joint erosion rates were 2-3 times higher than fluvial erosion alone, with wind-driven sand transport significantly enhancing sediment mobilization during rainfall events.

Table 3 Change of channel patterns of the Baerdong River from 1978 to 2015

Year	Channel width (m)	Channel area (m ²)	Erosion depth (m)
1978	147.7	14,115	2.5
1998	137.2	4,357.7	2.8
2005	90.4	5,720.1	2.4

Year	Channel width (m)	Channel area (m ²)	Erosion depth (m)
2014	50.1	5,828.8	3.1

[Figure 12: see original paper]

Figure 12 Change of valley patterns in the middle reaches of the Baerdong River from 1978 to 2014

Table 4 Landforms of aeolian-fluvial joint erosion in the Baerdong River Basin

Landform type	Geomorphic unit	Erosion pattern	Evolution characteristic
Riverbed dunes	Active sand dunes	Wind erosion dominant	Seasonal migration
Valley slopes	Gullies and rills	Water erosion dominant	Annual cycle
Terraces	Alluvial fans	Joint erosion	Decadal scale change

References

- [1] Song Yang, Liu Lianyou, Yan Ping. A review of soil erodibility in water and wind erosion research[J]. Journal of Geographical Sciences, 2006, 61(1): 77-88.
- [2] Bullard JE, McTainsh GH. Aeolian-fluvial interactions in dryland environments: Examples, concepts and Australia case study[J]. Progress in Physical Geography, 2003, 27: 471-501.
- [3] Bullard JE, McTainsh GH. Aeolian-fluvial interactions in dryland environments: Examples, concepts and Australia case study[J]. Progress in Physical Geography, 2003, 27: 471-501.
- [4] Gao Huijun, Lu Zhongzhen, et al. Remote Sensing Theory and Practice in Semi-Arid Ecological Fragile Zone in China[M]. Beijing: Science Press, 2007.
- [5] Jin Heling, Dong Guangrong. Preliminary study on the role of river wriggling in the evolution of Aeolian landforms in arid region: Taking Horan River as an example[J]. Journal of Desert Research, 2001, 21(4): 367-373.
- [6] Draut AE. Effects of river regulation on aeolian landscapes, Colorado River, southwestern USA[J]. Journal of Geophysics Research, 2012, 117: F02022.
- [7] Tooth S, Nanson GC. Distinctiveness and diversity of arid zone river systems[C]// Thomas DS G. Arid Zone Geomorphology: Process, Form and Change in Drylands. 3rd ed. John Wiley & Sons, New York, 269-300.

- [8] Farrra AA, Harvey AM. Late Quaternary interactions between aeolian and fluvial processes: A case study in the Northern UAE[J]. Journal of Arid Environments, 2004, 56: 235-248.
- [9] Simpson EL, Hilbert-Wolf HL, Simpson W S, et al. The interaction of aeolian and fluvial processes during deposition of the Upper Cretaceous capping sandstone member, Wahweap Formation, Kaiparowits Basin, Utah, USA[J]. Palaeogeography, Palaeoclimatology, Palaeoecology, 2008, 270: 19-28.
- [10] Grassland Resources Remote Sensing Application Investigation Team of Yikezhao League in Inner Mongolia. Study on Natural Resources and Environment of Ordos Plateau in Inner Mongolia[M]. Beijing: Science Press, 1990.
- [11] Liu Xiaoyan, Hou Suzhen, Chang Wenhua. Cause of main channel shrinkage occurred to the Inner Mongolia reaches of Yellow River[J]. Journal of Hydraulic Engineering, 2009, 40(9): 1048-1054.
- [12] Ma Yufeng. The Process and Mechanism of Aeolian-Fluvial Interactions in the Typical Area of Upstream of the Yellow River[D]. Beijing: Beijing Normal University, 2011.
- [13] Xie Yun, Liu Baoyuan, Zhang Wenbo. Study on standard of erosive rainfall[J]. Journal of Soil Water Conservation, 2000, 14(4): 6-11.
- [14] Wang Wanzhong. Study on the relations between rainfall characteristics and loss of soil in loess region[J]. Bulletin of Soil and Water Conservation, 1984, 4(2): 58-63.
- [15] Xu Zhong. Effects of wind and sand on the development of river valley[J]. Journal of Sediment Research, 1983(2): 67-73.
- [16] >cd. (cid:239)(cid:216)' G,aQ†6(cid:216)(cid:217)(cid:130)' +U ——* †eff,aU#Dqr[J]. b(cid:216)D|~9, 1984, 4(2): 58-63.
- [17] gd. a(cid:157)(cid:141)Yh(cid:154)' U%&[J]. (cid:240)(cid:157))* , 1983(2): 67-73.

Note: Figure translations are in progress. See original paper for figures.

Source: ChinaXiv – Machine translation. Verify with original.